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Abstract
Fifty-seven Duroc, 41 Landrace and 38 Yorkshire purebred sows in d 10 to 53 of pregnancy were aborted to synchronize estrus by using prostaglandin $F_2\alpha$ ($PGF_2\alpha$). Breed differences in time between injection of two 10-mg doses of $PGF_2\alpha$ and return to estrus were observed in these three breeds of pregnant sows during two breeding seasons. Duroc sows returned to estrus .9 d faster (P<.01) than Yorkshire and 1.3 d faster (P<.01) than Landrace sows. Seasonal differences were also observed. The mean days from injection to estrus were 1.8 d fewer (P<.01) for the spring season than in the fall season. All sows expressed estrus 5 to 11 d after injection. Normal gestation, parturition and piglet survival were observed in the sows after the treatment. Genetic differences in response to induced abortion and return to estrus could have implications in planned breeding and farrowing systems.

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Comments
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BREED DIFFERENCES IN RETURN TO ESTRUS AFTER $PGF_2\alpha$-INDUCED ABORTIONS IN SWINE[1,2]

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ABSTRACT

Fifty-seven Duroc, 41 Landrace and 38 Yorkshire purebred sows in d 10 to 53 of pregnancy were aborted to synchronize estrus by using prostaglandin $F_2\alpha$ ($PGF_2\alpha$). Breed differences in time between injection of two 10-mg doses of $PGF_2\alpha$ and return to estrus were observed in these three breeds of pregnant sows during two breeding seasons. Duroc sows returned to estrus .9 d faster ($P<.01$) than Yorkshire and 1.3 d faster ($P<.01$) than Landrace sows. Seasonal differences were also observed. The mean days from injection to estrus were 1.8 d fewer ($P<.01$) for the spring season than in the fall season. All sows expressed estrus 5 to 11 d after injection. Normal gestation, parturition and piglet survival were observed in the sows after the treatment. Genetic differences in response to induced abortion and return to estrus could have implications in planned breeding and farrowing systems.

(Key Words: Pigs, Estrus, Synchronization, Prostaglandins.)

Introduction

Synchronization of estrus in swine would be a useful management tool. Improvement of the efficiency and practicality of artificial insemination programs could result if large numbers of sows were in estrus at the same time. Manipulation of the time of estrus and ovulation would eliminate much of the time and labor involved in observing the animals for signs of estrus. Farrowing large numbers of sows simultaneously would also be valuable in cross-fostering experiments in research of maternal effects. Methods of estrus cycle manipulation in different species of livestock have been discussed by Hansel and Convey (1983).

Prostaglandin $F_2\alpha$ ($PGF_2\alpha$) causes luteolysis, release of relaxin from the corpora lutea and stimulation of uterine contractions sufficient to bring about delivery (Coggins et al., 1977; First and Bose, 1979). Progesterone production by the corpora lutea of pregnant sows must be terminated before parturition can occur. Nara and First (1977) showed that $PGF_2\alpha$ is the natural agent causing luteolysis (termination of progesterone production at term).

Prostaglandin $F_2\alpha$ is not luteolytic in the pig until about d 12 of the estrous cycle (Diehl and Day, 1974). For synchronization of estrus in nonpregnant sows, estrogens must be administered on d 10 to 14 to maintain the corpora lutea, which are regressed 5 to 20 d later with $PGF_2\alpha$. Estrus occurs 4 to 6 d after $PGF_2\alpha$ injections (Guthrie, 1975). The use of $PGF_2\alpha$ to abort pregnant sows circumvents the need for injections of estrogens to maintain the corpora lutea.

The object of this experiment was to determine whether genetic differences exist in response to $PGF_2\alpha$ used to synchronize estrus.

Materials and Methods

Animals. This study included 54 purebred sows bred to nine purebred boars in the fall of 1983 and 82 purebred sows bred to 11 purebred boars in the spring of 1984 at Iowa State University's Bilsland Swine Breeding Research Farm. The sows were of the Duroc (57), Landrace (41) and Yorkshire (38) breeds and ranged from first to seventh parity. The pedigree lines within these breeds are considered representative of those currently produced in the United States because semen and boars have been routinely introduced into the herd.

Procedures. The sows were first bred by penning them in groups of 10 to 15, with four to

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six boars on outside concrete lots. They were observed twice daily and dates of standing heat and breeding were recorded. Injections of $PGF_2\alpha$ were given 10 to 53 d after breeding to synchronize sows weaned over a 30-d period. Time after conception must be sufficient for corpora lutea to be present, but $PGF_2\alpha$ will not regress corpora lutea midterm in pregnancy when levels of progesterone are high (Coggins et al., 1977).

Two milliliters of Lutalyse (10 mg dinoprost) was administered intramuscularly 3.8 cm deep in the shoulder. The injection was repeated 16 h later to increase the probability that each animal received sufficient dosage to cause abortion. Six sows that did not show estrus were assumed not pregnant at the time of injection and were not included in the study.

Sows were housed separately from boars after injections were administered. Estrus checks were made once daily by providing supervised contact with boars for 3 h. Estrus was expressed 5 to 11 d after first injection, and recorded to the nearest whole day. The sows were inseminated naturally during this estrus by using hand-mating to semen-checked, mature boars. The sows were randomly assigned to boars, and each boar was mated to sows of all three breeds. Different boars were used each season.

The source of $PGF_2\alpha$ was Lutalyse® (dinoprost tromethamine[3]). The use of Lutalyse for induction of parturition in swine was approved by the Food and Drug Administration in February 1984.

Statistical Analysis. Data were analyzed by using the assumed model:

$$y_{ijklm} = \mu + b_i + d_j + s_k + bs_{ik} + g_m + e_{ijklm},$$

where

y_{ijklm} = days from first injection to estrus,
μ = overall constant,
b_i = fixed effect of i^{th} breed,
d_j = random effect of j^{th} dam within breed, with expectations mean zero and variance σ_d^2,
s_k = fixed effect of k^{th} season,
bs_{ik} = breed × season interaction,
g_m = (covariate) regression of days until return to estrus on gestation length before injection,
e_{ijklm} = random residual, with expectations mean zero and variance σ_e^2.

Tests of significance (F-tests) for breed effects were tested with the mean square for dams within breeds used as the error term. All other effects were tested by using the residual mean square. All F-tests were approximate due to unequal numbers. A preliminary analysis using a model including parity of dam was examined. Parity was not significant and was discarded in the final analysis. The regressions of gestation length before injection on days to estrus for the individual breeds were not found to be heterogeneous ($P>.05$) so a single pooled regression was used in the final analysis.

Results

Factors analyzed affecting days until return to estrus after injection of $PGF_2\alpha$ are given in table 1. Differences among breeds and between seasons can be seen in table 2. Duroc sows returned to estrus .9 d faster ($P<.01$) than Yorkshire and 1.3 d faster than Landrace sows. The means for all three breeds were lower in the spring season. Breed × season interaction was significant because the proportional differences among breeds for the two seasons were different; however, rankings were the same for both seasons. The effect of length of gestation before injection on return to estrus was not significant.

Conception rates after breeding during the first estrus after abortion were 73.7, 81.6 and 87.8% for the Duroc, Yorkshire and Landrace sows, respectively. Sows were assumed to be pregnant if they did not have an estrus cycle 21 d after breeding. These were not significantly different and are at an acceptable level for a single breeding.

Durocs, which returned to estrus faster, had a lower conception rate. Landrace, which took longer to return to estrus, had a higher conception rate.

Discussion

Breed and seasonal differences were found for the length of time between injection of $PGF_2\alpha$ and estrus. Use of this hormone for estrous synchronization by abortion would depend on the genetic background of the popula-

[3] The Upjohn Co., Kalamazoo, MI.

TABLE 1. ANALYSIS OF VARIANCE OF FACTORS AFFECTING DAYS UNTIL RETURN TO ESTRUS AFTER INJECTION OF LUTALYSE

Source of variation	df	Mean squares	Error term
Breed	2	14.4**	Dam/breed
Dam/breed	93	.9	Residual
Season	1	41.4**	Residual
Breed X season	2	3.0*	Residual
Gestation length	1	1.1	Residual
Residual	36	.77	
R^2 = .89			

*P<.05.

**P<.01.

tion and environmental factors. There could also be genetic differences in parturition induction with use of $PGF_2\alpha$ at or near term. Genetic effects on response to hormones may point to genetic control of other aspects of reproduction not yet investigated. Variance among different genotypes as to their control of reproductive functions may need to be considered when these functions are manipulated. No previous studies of breed or genetic differences of response to $PGF_2\alpha$ in swine have been reported.

McAllister et al. (1983) showed, in field studies, that parturition induction with Lutalyse was followed by normal parturition, lactation and subsequent estrus cycles. Subsequent gestation and farrowing of the sows in this study was observed as normal, and the number of pigs born alive would indicate no lasting detrimental effects from the treatment. Breed means for these observations are presented in table 3.

This experiment was successful in synchronizing estrus so that groups of sows could be bred in a period of 6 d. Use of this method of synchronization, followed by induced parturition, could cause a large group of sows to farrow within approximately 2 d. Some variability in the procedure can be explained by differences in breed of the sows involved. Closer synchronization could be achieved in groups of sows that are of similar genetic background. This particular method of synchronization may not be cost effective in some situations because of the time and expense involved in breeding the sows the first time only to abort them. However, it could be a valuable tool in synchronizing recipient sows for embryo transfer and in research where cross-fostering is important.

TABLE 2. ESTIMATED BREED AND SEASON MEANS[a] AND STANDARD ERRORS FOR DAYS UNTIL ESTRUS AFTER INJECTION OF LUTALYSE

	Fall 1983		Spring 1984		Combined	
Breed	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Duroc	6.7^{b}	.3	6.0^{d}	.2	6.3^{b}	.1
Yorkshire	8.1^{c}	.3	6.3^{de}	.2	7.2^{c}	.1
Landrace	8.5^{c}	.2	6.6^{e}	.2	7.6^{c}	.2

[a]Least-squares means.

[b,c]Means in the same column with no common superscripts differ (P<.01).

[d,e]Means in the same column with no common superscripts differ (P<.05).

TABLE 3. BREED MEANS FOR GESTATION LENGTH, NUMBER BORN ALIVE AND NUMBER STILLBORN FOR THE PREGNANCIES AFTER SYNCHRONIZATION

Breed	Gestation length (d)		Number born alive		Number stillborn	
	Mean	SD	Mean	SD	Mean	SD
Duroc	115.2	1.8	9.9	3.2	.5	.7
Yorkshire	115.9	1.8	9.9	2.9	1.0	1.2
Landrace	115.5	1.5	10.5	3.4	1.4	2.0

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